WHAT IS CLAIMED:

1. A bi-directional optical-amplifier module comprising:

a first optical amplifier;

a second optical amplifier;

a third optical amplifier;

a fourth optical amplifier;

a mid-stage device for performing a desired signal processing for an upward or downward optical signal passing therethrough;

a first optical-signal-path-setting device for supplying an optical signal inputted to a first input/output terminal of the bi-directional optical-amplifier module, while outputting an optical signal outputted from the fourth optical amplifier to the first input/output terminal;

a second optical-signal-path-setting device for supplying an optical signal inputted to a second input/output terminal of the bi-directional optical-amplifier module, while outputting an optical signal outputted from the third optical amplifier to the second input/output terminal;

a third optical-signal-path-setting device for outputting an optical signal outputted from the first optical amplifier to a first input/output terminal of the mid-stage device, while supplying an optical signal outputted from the first input/output terminal of the mid-stage device to the fourth optical amplifier; and,

a fourth optical-signal-path-setting device for outputting an optical signal outputted from the second optical amplifier to a second input/output terminal of the mid-stage device,

while supplying an optical signal outputted from the second input/output terminal of the mid-stage device to the third optical amplifier.

2. The optical-amplifier module of claim 1, wherein each of the first and fourth optical-signal-path-setting devices is a wavelength-selective coupler, and each of the second and third optical-signal-path-setting devices is a circulator.

3. The optical-amplifier module of claim 1, wherein each of the first and fourth optical-signal-path-setting devices is a circulator, and each of the second and third optical-signal-path-setting devices is a wavelength-selective coupler.

4. The optical-amplifier module of claim 1, wherein each of the first and third optical-signal-path-setting devices is a circulator, and each of the second and fourth optical-signal–path-setting devices is a wavelength-selective coupler.

5. The optical-amplifier module of claim 1, wherein each of the first through fourth optical-signal-path-setting devices is a wavelength-selective coupler.

6. The optical-amplifier module of claim 1, wherein one of the first through fourth optical-signal-path-setting devices is a circulator, and each of the remaining optical–signal-path-setting devices is a wavelength-selective coupler.

7. The optical-amplifier module of claim 1, wherein the mid-stage device comprises at least one of dispersion-compensating means, optical-fiber-gain flattening means, and means for removing accumulated noise of optical amplifiers and controlling the power of optical signals.

8. A bi-directional optical-amplifier module having first and second input/output ports to amplify downward/upward optical signals traveling bi-directionally, comprising:

a first wavelength-selective coupler connected at a common terminal thereof to the first input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a first uni-directional optical amplifier connected at an input terminal thereof to an output terminal of the first wavelength-selective coupler;

a fourth uni-directional optical amplifier connected at an output terminal thereof to an input terminal of the first wavelength-selective coupler;

a first circulator connected to an output terminal of the first uni-directional optical amplifier and an input terminal of the fourth uni-directional optical amplifier at input and output terminals thereof, respectively;

a second wavelength-selective coupler connected at a common terminal thereof to the second input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a second uni-directional optical amplifier connected at an input terminal thereof to an output terminal of the second wavelength-selective coupler;

a third uni-directional optical amplifier connected at an output terminal thereof to an input terminal of the second wavelength-selective coupler;

a second circulator connected to an output terminal of the second uni-directional optical amplifier and an input terminal of the third uni-directional optical amplifier at input and output terminals thereof, respectively; and,

a mid-stage device connected between the common terminals of the first and second circulators, the mid-stage device comprising at least one of dispersion-compensating means, optical-fiber-gain flattening means, and means for removing accumulated noise of optical amplifiers and controlling power of optical signals.

9. The optical-amplifier module of claim 8, wherein each of the uni-directional optical amplifiers is a rare earth-doped fiber amplifier, a semiconductor optical amplifier, or a Raman amplifier.

10. The optical-amplifier module of claim 8, wherein each of the wavelength-selective couplers comprises a wavelength multiplexer for coupling or separating optical signals having wavelengths of different bands.

11. The optical-amplifier module of claim 8, wherein each of the wavelength-selective couplers comprises a circulator having an input terminal, an output terminal, and a common terminal, a first bandpass filter connected to the input terminal of the

circulator and adapted to transmit an optical signal of a predetermined wavelength band while cutting off optical signals of other wavelength bands, and a second bandpass filter connected to the output terminal of the circulator, the second bandpass filter having a passband and a cut-off band opposite to those of the first bandpass filter.

12. The optical-amplifier module of claim 8, wherein each of the wavelength-selective couplers comprises a wavelength interleaver for coupling or separating optical signals having wavelengths adjacent to each other.

13. The optical-amplifier module of claim 8, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first comb filter connected to an input terminal of the circulator, having passbands or cut-off bands repeated at a predetermined interval; and, a second comb filter connected to the output terminal of the circulator, having passbands or cut-off bands repeated at an interval corresponding to the interval of the first comb filter and an absolute value corresponding to half the interval of the first comb filter.

14. A bi-directional optical-amplifier module having first and second input/output ports to amplify downward/upward optical signals traveling bi-directionally, comprising:

a first circulator connected at a common terminal thereof to the first input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a first uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the first circulator;

a fourth uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the first circulator;

a first wavelength-selective coupler connected to an output terminal of the first uni-directional optical amplifier and an input terminal of the fourth uni-directional optical amplifier to input and output terminals thereof, respectively;

a second wavelength-selective coupler connected to a common terminal thereof to the second input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a second uni-directional optical amplifier connected at an input terminal thereof to an output terminal of the second wavelength-selective coupler;

a third uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the second wavelength-selective coupler;

a second circulator connected to an output terminal of the second uni-directional optical amplifier and an input terminal of the third uni-directional optical amplifier at input and output terminals thereof, respectively; and,

a mid-stage device connected between the common terminal of the first wavelength-selective coupler and the common terminal of the second circulator, the mid-stage device comprising at least one of dispersion-compensating means, optical-fiber-gain flattening means, and means for removing accumulated noise of optical amplifiers and controlling power of optical signals.

15. The optical-amplifier module of claim 14, wherein each of the uni-directional optical amplifiers is a rare earth-doped fiber amplifier, a semiconductor optical amplifier, or a Raman amplifier.

16. The optical-amplifier module of claim 14, wherein each of the wavelength-selective couplers comprises a wavelength multiplexer for coupling or separating optical signals having wavelengths of different bands.

17. The optical-amplifier module of claim 14, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first bandpass filter connected to the input terminal of the circulator and adapted to transmit an optical signal of a predetermined wavelength band, while cutting off optical signals of other wavelength bands; and a second bandpass filter connected to the output terminal of the circulator, the second bandpass filter having a passband and a cut-off band opposite to those of the first bandpass filter.

18. The optical-amplifier module of claim 14, wherein each of the wavelength-selective couplers comprises a wavelength interleaver for coupling or separating optical signals having wavelengths adjacent to each other.

19. The optical-amplifier module of claim 14, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first comb filter connected to an input terminal of the circulator having passbands or cut-off bands repeated at a predetermined interval; and, a second comb filter connected to the output terminal of the circulator having passbands or cut-off bands repeated at an interval corresponding to the interval of the first comb filter and an absolute value corresponding to half the interval of the first comb filter.

20. A bi-directional optical-amplifier module having first and second input/output ports to amplify downward/upward optical signals traveling bi-directionally, comprising:

a first circulator connected to a common terminal thereof to the first input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a first uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the first circulator;

a fourth uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the first circulator;

a first wavelength-selective coupler connected to an output terminal of the first

uni-directional optical amplifier and an input terminal of the fourth uni-directional optical amplifier to input and output terminals thereof, respectively;

a second circulator connected to a common terminal thereof to the second input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a second uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the second circulator;

a third uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the second circulator;

a second wavelength selective coupler connected to an output terminal of the second uni-directional optical amplifier and an input terminal of the third uni-directional optical amplifier at input and output terminals thereof, respectively; and,

a mid-stage device connected between the common terminals of the first and second wavelength-selective couplers, the mid-stage device comprising at least one of dispersion-compensating means, optical-fiber-gain flattening means, and means for removing accumulated noise of optical amplifiers and controlling power of optical signals.

21. The optical-amplifier module of claim 20, wherein each of the uni-directional optical amplifiers is a rare earth-doped fiber amplifier, a semiconductor optical amplifier, or a Raman amplifier.

22. The optical-amplifier module of claim 20, wherein each of the wavelength-selective couplers comprises a wavelength multiplexer for coupling or separating optical signals having wavelengths of different bands.

23. The optical-amplifier module of claim 20, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first bandpass filter connected to the input terminal of the circulator and adapted to transmit an optical signal of a predetermined wavelength band while cutting off optical signals of other wavelength bands; and a second bandpass filter connected to the output terminal of the circulator, the second bandpass filter having a passband and a cut-off band opposite to those of the first bandpass filter.

24. The optical-amplifier module of claim 20, wherein each of the wavelength-selective couplers comprises a wavelength interleaver for coupling or separating optical signals having wavelengths adjacent to each other.

25. The optical-amplifier module of claim 20, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first comb filter connected to an input terminal of the circulator having passbands or cut-off bands repeated at a predetermined interval; and, a second comb filter connected to the output terminal of the circulator having passbands or cut-off bands repeated at an interval corresponding to the interval of the first comb filter and

an absolute value corresponding to half the interval of the first comb filter.

26. A bi-directional optical-amplifier module having first and second input/output ports to amplify downward/upward optical signals traveling bi-directionally, comprising:

a first wavelength-selective coupler connected to a common terminal thereof to the first input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a first uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the first-wavelength selective coupler;

a fourth uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the first wavelength-selective coupler;

a third wavelength-selective coupler connected to an output terminal of the first uni-directional optical amplifier and an input terminal of the fourth uni-directional optical amplifier to input and output terminals thereof, respectively;

a second wavelength-selective coupler connected to a common terminal thereof to the second input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a second uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the second wavelength-selective coupler;

a third uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the second wavelength-selective coupler;

a fourth wavelength-selective coupler connected to an output terminal of the second

uni-directional optical amplifier and an input terminal of the third uni-directional optical amplifier at input and output terminals thereof, respectively; and,

a mid-stage device connected between the common terminals of the third and fourth wavelength-selective couplers, the mid-stage device comprising at least one of dispersion compensating means, optical-fiber-gain flattening means, and means for removing accumulated noise of optical amplifiers and controlling power of optical signals.

27. The optical-amplifier module of claim 26, wherein each of the uni-directional optical amplifiers is a rare earth-doped fiber amplifier, a semiconductor optical amplifier, or a Raman amplifier.

28. The optical-amplifier module of claim 26, wherein each of the wavelength-selective couplers comprises a wavelength multiplexer for coupling or separating optical signals having wavelengths of different bands.

29. The optical-amplifier module of claim 26, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first bandpass filter connected to the input terminal of the circulator and adapted to transmit an optical signal of a predetermined wavelength band, while cutting off optical signals of other wavelength bands; and, a second bandpass filter connected to the output terminal of the circulator, the second bandpass filter having a

passband and a cut-off band opposite to those of the first bandpass filter.

30. The optical-amplifier module of claim 26, wherein each of the wavelength-selective couplers comprises a wavelength interleaver for coupling or separating optical signals having wavelengths adjacent to each other.

31. The optical-amplifier module of claim 26, wherein each of the wavelength selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first comb filter connected to an input terminal of the circulator having passbands or cut-off bands repeated at a predetermined interval; and, a second comb filter connected to the output terminal of the circulator having passbands or cut-off bands repeated at an interval corresponding to the interval of the first comb filter and an absolute value corresponding to half the interval of the first comb filter.

32. A bi-directional optical-amplifier module having first and second input/output ports to amplify downward/upward optical signals traveling bi-directionally, comprising:

a circulator connected to a common terminal thereof to the first input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a first uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the circulator;

a fourth uni-directional optical amplifier connected to an output terminal thereof to an

input terminal of the circulator;

a first wavelength-selective coupler connected to an output terminal of the first uni-directional optical amplifier and an input terminal of the fourth uni-directional optical amplifier to input and output terminals thereof, respectively;

a second wavelength-selective coupler connected to a common terminal thereof to the second input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a second uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the second wavelength-selective coupler;

a third uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the second wavelength-selective coupler;

a third wavelength-selective coupler connected to an output terminal of the second uni-directional optical amplifier and an input terminal of the third uni-directional optical amplifier to input and output terminals thereof, respectively; and,

a mid-stage device connected between the common terminals of the first and third wavelength-selective couplers, the mid-stage device comprising at least one of dispersion-compensating means, optical-fiber-gain flattening means, and means for removing accumulated noise of optical amplifiers and controlling power of optical signals.

33. The optical-amplifier module of claim 32, wherein each of the uni-directional optical amplifiers is a rare earth-doped fiber amplifier, a semiconductor optical amplifier, or a Raman amplifier.

34. The optical-amplifier module of claim 32, wherein each of the wavelength-selective couplers comprises a wavelength multiplexer for coupling or separating optical signals having wavelengths of different bands.

35. The optical-amplifier module of claim 32, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first bandpass filter connected to the input terminal of the circulator and adapted to transmit an optical signal of a predetermined wavelength band, while cutting off optical signals of other wavelength bands; and, a second bandpass filter connected to the output terminal of the circulator, the second bandpass filter having a passband and a cut-off band opposite to those of the first bandpass filter.

36. The optical-amplifier module of claim 32, wherein each of the wavelength-selective couplers comprises a wavelength interleaver for coupling or separating optical signals having wavelengths adjacent to each other.

37. The optical-amplifier module of claim 32, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first comb filter connected to an input terminal of the circulator, the circulator having passbands or cut-off bands repeated at a predetermined interval; and a second comb filter connected to the output terminal of the circulator having passbands or cut-off bands repeated at an interval corresponding to the interval of the first

comb filter and an absolute value corresponding to half the interval of the first comb filter.

38. A bi-directional optical-amplifier module having first and second input/output ports to amplify downward/upward optical signals traveling bi-directionally, comprising:

a first wavelength-selective coupler connected to a common terminal thereof to the first input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a first uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the first wavelength-selective coupler;

a fourth uni-directional optical amplifier connected at an output terminal thereof to an input terminal of the first wavelength-selective coupler;

a circulator connected to an output terminal of the first uni-directional optical amplifier and an input terminal of the fourth uni-directional optical amplifier at input and output terminals thereof, respectively;

a second wavelength-selective coupler connected to a common terminal thereof to the second input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a second uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the second wavelength-selective coupler;

a third uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the second wavelength-selective coupler;

a third wavelength-selective coupler connected to an output terminal of the second

uni-directional optical amplifier and an input terminal of the third uni-directional optical amplifier to input and output terminals thereof, respectively; and,

a mid-stage device connected between the common terminal of the circulator and the common terminal of the third wavelength-selective coupler, the mid-stage device comprising at least one of dispersion compensating means, optical-fibe- gain flattening means, and means for removing accumulated noise of optical amplifiers and controlling power of optical signals.

39. The optical-amplifier module of claim 38, wherein each of the uni-directional optical amplifiers is a rare earth-doped fiber amplifier, a semiconductor optical amplifier, or a Raman amplifier.

40. The optical-amplifier module of claim 38, wherein each of the wavelength-selective couplers comprises a wavelength multiplexer for coupling or separating optical signals having wavelengths of different bands.

41. The optical-amplifier module of claim 38, wherein each of the wavelength -elective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first bandpass filter connected to the input terminal of the circulator and adapted to transmit an optical signal of a predetermined wavelength band, while cutting off optical signals of other wavelength bands; and, a second bandpass filter connected to the output terminal of the circulator, the second bandpass filter having a passband and a cut-off

band opposite to those of the first bandpass filter.

42. The optical-amplifier module of claim 38, wherein each of the wavelength-selective couplers comprises a wavelength interleaver for coupling or separating optical signals having wavelengths adjacent to each other.

43. The optical-amplifier module of claim 38, wherein each of the wavelength-selective couplers comprises: a circulator having an input terminal, an output terminal, and a common terminal; a first comb filter connected to an input terminal of the circulator having passbands or cut-off bands repeated at a predetermined interval; and, a second comb filter connected to the output terminal of the circulator having passbands or cut-off bands repeated at an interval corresponding to the interval of the first comb filter and an absolute value corresponding to half the interval of the first comb filter.

44. A bi-directional optical-amplifier module having first and second input/output ports to amplify downward/upward optical signals traveling bi-directionally, comprising:

a first wavelength-selective coupler connected to a common terminal thereof to the first input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a first uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the first wavelength-selective coupler;

a fourth uni-directional optical amplifier connected to an output terminal thereof to an

input terminal of the first wavelength-selective coupler;

a second wavelength-selective coupler connected to a common terminal thereof to the second input/output port and adapted to perform a separation/combination of optical signals passing therethrough bi-directionally;

a second uni-directional optical amplifier connected to an input terminal thereof to an output terminal of the second wavelength-selective coupler;

a third uni-directional optical amplifier connected to an output terminal thereof to an input terminal of the second wavelength-selective coupler;

a third wavelength-selective coupler connected to respective output terminals of the first and second uni-directional optical amplifiers to first and second input terminals thereof;

a fourth wavelength-selective coupler connected to respective output terminals of the third and fourth uni-directional optical amplifiers to first and second input terminals thereof; and,

a mid-stage device connected between the common terminals of the third and fourth wavelength-selective couplers, the mid-stage device comprising at least one of dispersion-compensating means, optical-fiber-gain flattening means, and means for removing accumulated noise of optical amplifiers and controlling power of optical signals.

45. The optical-amplifier module of claim 44, wherein each of the uni-directional optical amplifiers is a rare earth-doped fiber amplifier, a semiconductor optical amplifier, or a Raman amplifier.

46. The optical-amplifier module of claim 44, wherein each of the wavelength-selective couplers comprises a wavelength multiplexer for coupling or separating optical signals having wavelengths of different bands.

47. The optical-amplifier module of claim 44, wherein each of the wavelength-selective couplers comprises a wavelength interleaver for coupling or separating optical signals having wavelengths adjacent to each other.